Design, Development and Pilot scale installation of a Solar powered Sanitary Napkin Vending Machine (SSNVM) for rural schools in India.

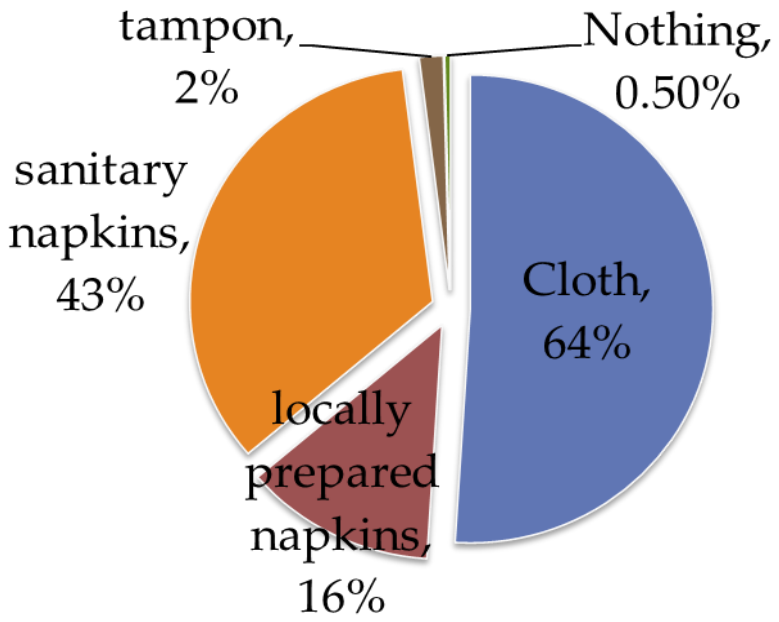
Funded by:- The International Solar Innovation Council (InSIC)

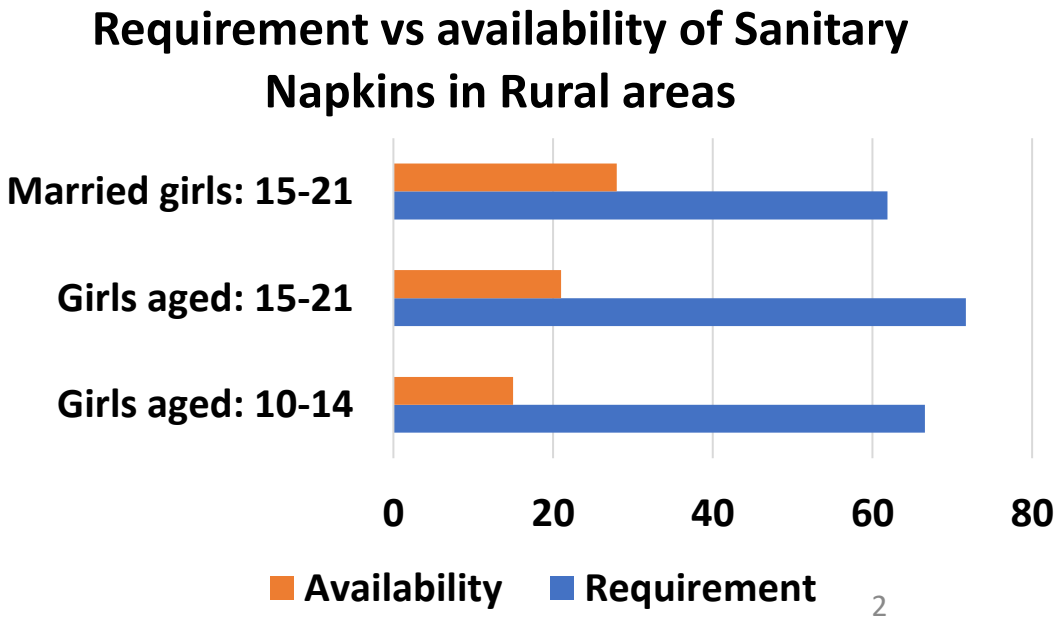
Implemented By:-
Mr. Anupam Baral, Proprietor, Geetanjali Solar Enterprise (Lead Organization)
Ms. Rai Dhar Ruchi, Project Associate (SSNVM), NBIRT (Technical Partner)

IDENTIFIED PROBLEMS

- Unavailability of Sanitary Napkins in rural areas
- Inefficient and Inappropriate distribution of Sanitary Napkins in rural schools
- Health-related issues in girl students due to inadequate use of sanitary napkins
- Increased drop-out rates of girl students due to the unavailability of sanitary napkins
- Hesitant to purchase sanitary napkins from local medicinal shops
- Improper monitoring of sanitary napkin distribution leading to erratic per capita availability
- 40% of girls remained absent from school during their menstruation in India.

Some NGOs have provided sanitary napkin vending machines based on conventional electricity, but due to erratic power supply in most rural areas, the users face many problems in dispensing sanitary pads. Thus, eventually, the machine becomes un-operational.





In order to solve this problem, Geetanjali Solar Enterprise, a leading solar company submitted a proposal to InSIC which was approved under small grants scheme 2022.

PROJECT OBJECTIVES

1. To upgrade the traditional Human resource based sanitary napkin distribution process to an automated and robust process.

2. To ensure a timely and uninterrupted distribution of sanitary napkins in rural areas through a technologically robust machine by utilization of Solar PV technology as a power source.

3. To replace high-power and high-cost existing sanitary napkin dispensing systems with a low-power and low-cost solar operated variant.

4. Development of an IoT-based monitoring and control system for the sanitary napkin vending machine, by which it can be monitored by NGOs for timely refiling and checking the status of the machine.

TARGET BENEFICIARIES

- The target beneficiaries of the proposed project are girls studying in rural schools in India who do not have proper access to sanitary napkins.
- The system can be accessed by school girls, staff and female outsiders.
- Special emphasis on ensuring access to sanitary napkins for girls belonging to Economically Weaker Sections.
- The proposed system will be developed and installed in Bolpur Sikshaniketan Ashram Vidyalaya, West Bengal where electricity is erratic (not available during school hours for 3-4 hrs each day).

SURVEY OF EXISTING SYSTEMS IN SCHOOLS & COLLEGES

Name Of School/College	Types Of SNVM	Total Stock Holding Capacity	Operational Mode & System Rating	Stock Availability Visible	Remarks
Basanti Devi College, Educational Institute, Kolkata	Automatic	26 Packets	Coin reader with (memory) accepts only 10 rupees coin. Power Rating: 12W	Available	Machine was found not operational as there was a problem in the control circuit.
Visva Bharati, Bolpur, Santiniektan University, Educational Institute	Manual	50 Sanitary Napkin	Accepts 5 Rupees coin. Dispenses one pad at once when lever is rotated.	Available	Machine was found not operational due to a mechanical problem inside the coin acceptor within the machine.
Belgharia Deshapriya Vidyaniketan Girls' High School, Kolkata	Automatic	25 Packets	Accepts a Coin of Rs. 10. Power rating: 15W	Available	Machine was found malfunctioning during operation.

SNAPSHOTS OF EXISTING MACHINES

Automatic Sanitary Napkin Vending Machine

Manually operated Sanitary Napkin Vending Machine

Automatic Sanitary Napkin Vending Machine

SURVEY OF EXISTING VENDORS

Name Of The Vendor	Type of Machine Fabricated	Cost of Machine	Products sold per year	Total Stock Holding Capacity per machine	Coin Acceptance	Remarks
Rayaan Tranding & Service	Automatic	Rs. 13,500	500 to 700	100 Napkins Higher capacity is also available	Accepts coin of Rs. 5/-	Inappropriate dispensing of sanitary napkins. Poor structural material used.
Rudra Hygnecare	Automatic	Rs. 19,500	200 to 400	100 Napkins	Accepts coins of Rs. 1,2 & 5/-	Poor-quality wires used. Machine frequently malfunctions
Sanmak	Automatic	Rs. 15,450	450 to 800	50 Napkins	Accepts coin of Rs. 1,2, 5, 10/-	Non availability of power control circuit.

EXISTING TECHNOLOGIES & TECHNOLOGICAL GAPS

- Sanitary napkin Vending Machines are available in the market but operates only with grid power.
- Operating the machine using unregulated power supply or severe power fluctuations leads to damage the electronic parts, increases the maintenance cost or else the machine becomes defunct. This is more prominent in rural areas.
- As conventional vending machines have primitive dispensing systems, inaccurate dispensing is frequent.
- Remote monitoring system is not available to monitor the available sanitary napkin stocks, leading to inefficient management for stock refilling.
- Unable to display and revalidate actual sanitary napkin stock.
- Existing vending machines have low stock holding capacities, which require frequent refilling. It is not feasible in rural areas. The prices are also high of a single individual machine.

In the absence of Power, the vending machine becomes non-operational very frequently and finally gets locked.

Sanitary Napkin Vending Machine at a rural school

Defunct Sanitary Napkin Vending Machine

SOLUTION PROPOSED

- As grid is erratic in rural areas, an alternative energy source which is readily available will be required. Solar PV was thus chosen to be the best option.
- Existing systems don’t have a Solar Power facility installed. Thus an appropriate smart controller needs to be developed to regulate the power and charge a battery effectively.
- The machine is usually operated in school hours; thus, a dawn-to-dusk system was proposed, which will operate the machine from solar and battery.
- To minimize the cost of the solar-powered unit, the solar and battery capacity was optimized to run for 3-4 hrs.
- An Intelligent controller was proposed which can effectively take optimal power from the SPV and charge the battery using MPPT algorithm and carry out power management.
- Existing systems do not show the system status and power status, the same was proposed to be incorporated into the controller.
- To monitor the system effectively, a simple IoT system was also proposed.

MATERIAL PROCUREMENT

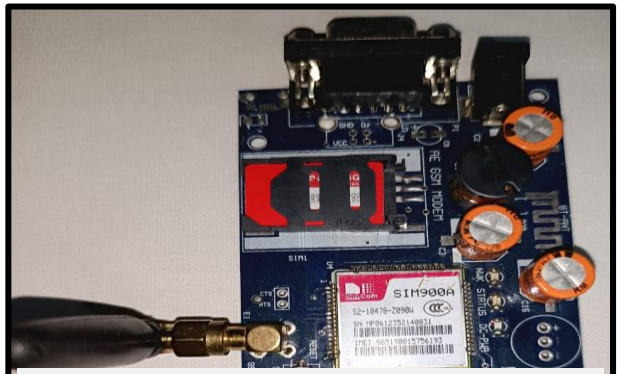
Solar Panel 20Wp

Digital Multimeter

Solar power meter

Temperature Detector

Energy Meter



IoT Controller

Clamp Meter

PROBLEMS FOUND IN EXISTING SYSTEMS

List of problems found in the existing Sanitary Napkin Vending Machine

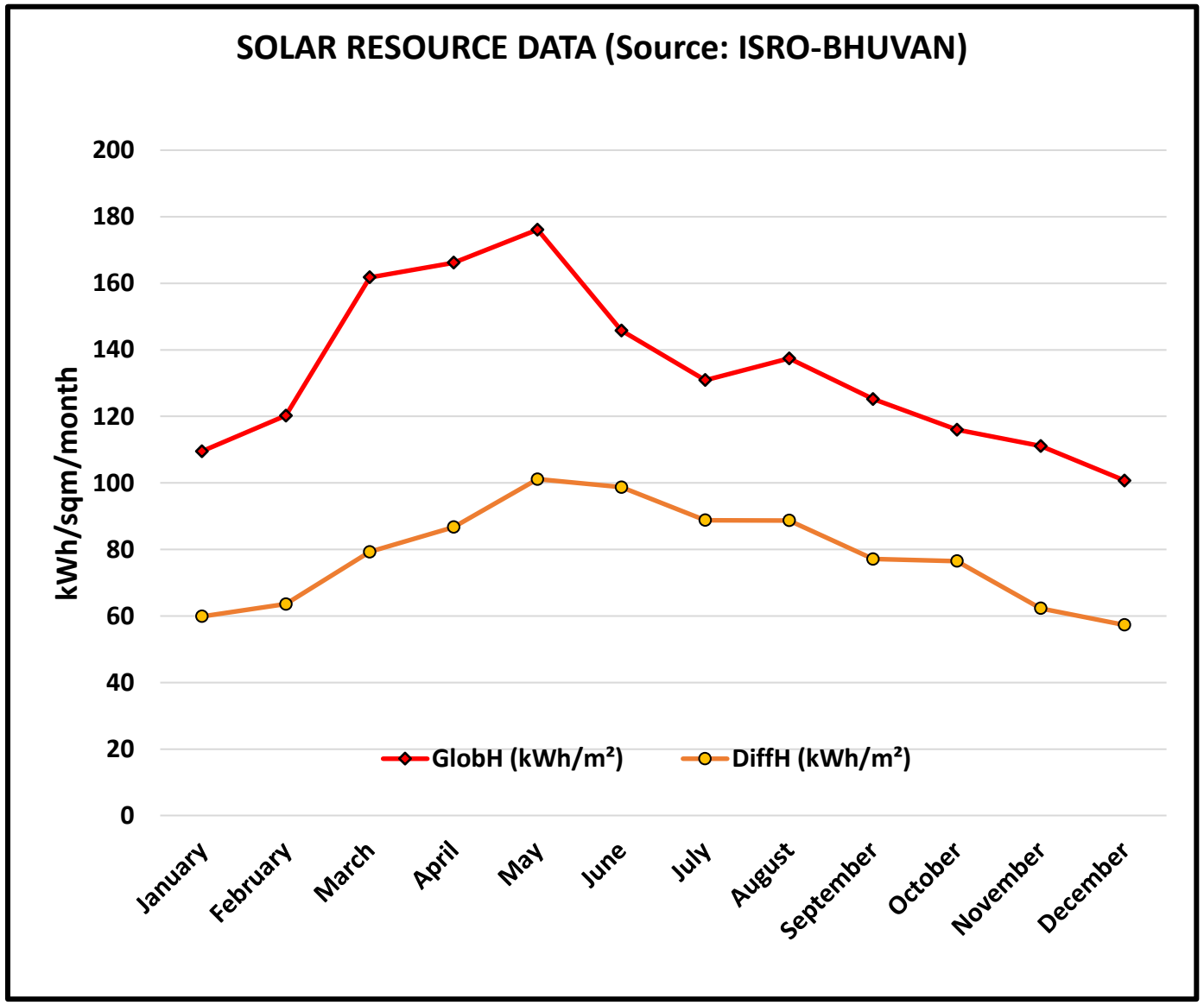
Technical Problems-

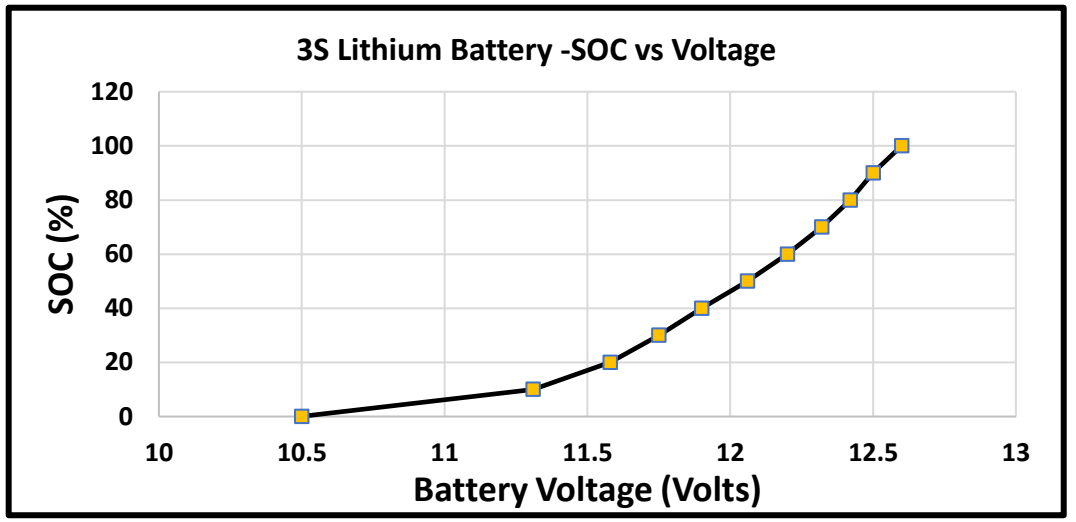
1. Reverse power flow detected.
2. Use of poor-quality wires.
3. AC-DC Adapter, & Load all connected using a common busbar.
4. Non availability of power control circuit.
5. Proper door bending clearance is not available.
6. Disturbance in pad arrangements found while the machine is in operation.
7. Slope is not adequate thus dispensing problem is faced.

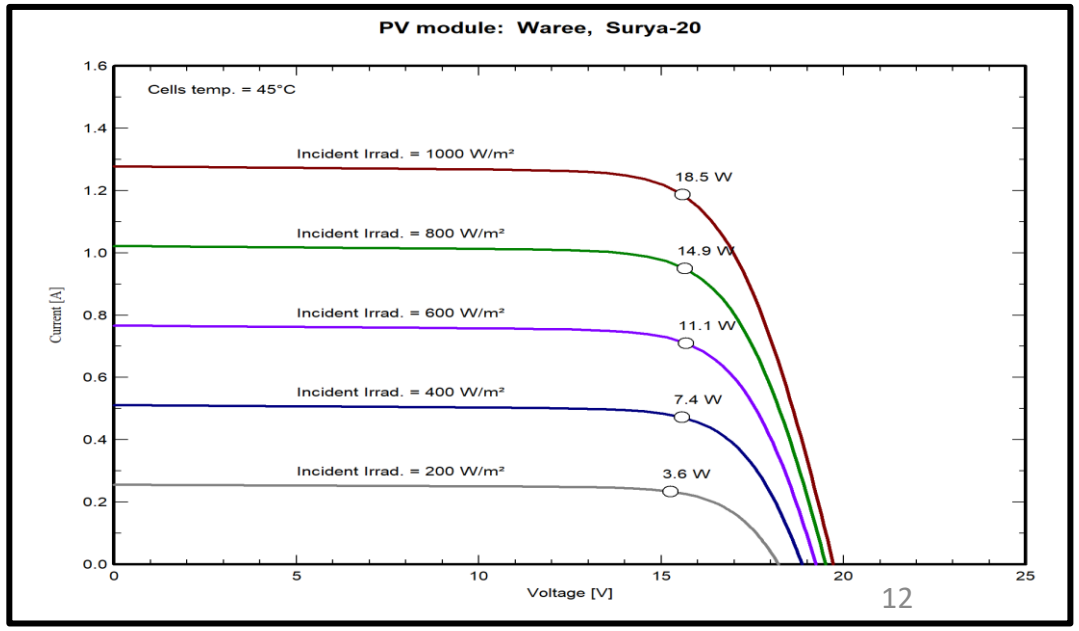
Operational Problems-

1. Dispensed pad is not easily accessible.
2. Machine Malfunctions when grid power is erratic
3. Base load is high for long operational hours.

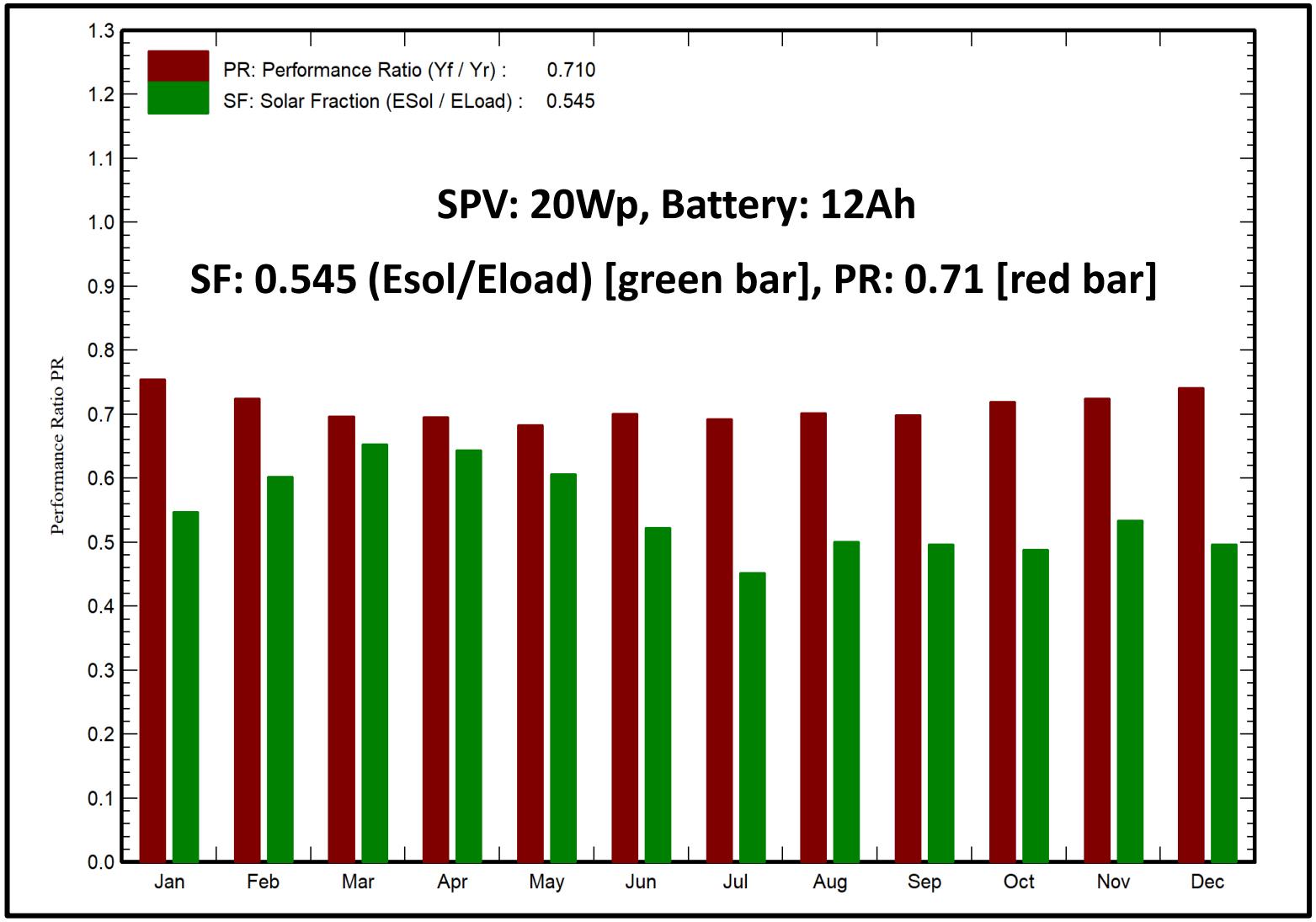
PERFORMANCE SIMULATION OF THE SOLAR UNIT





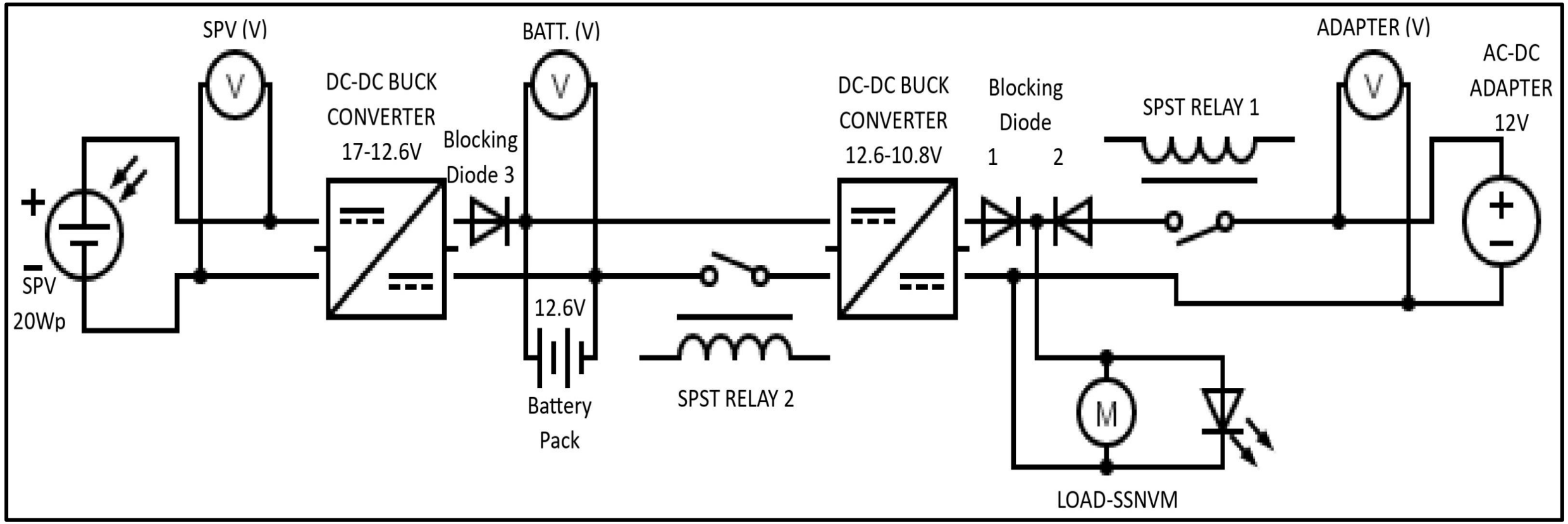


SIMULATION RESULTS AND OPTIMIZATION OF SYSTEM DESIGN



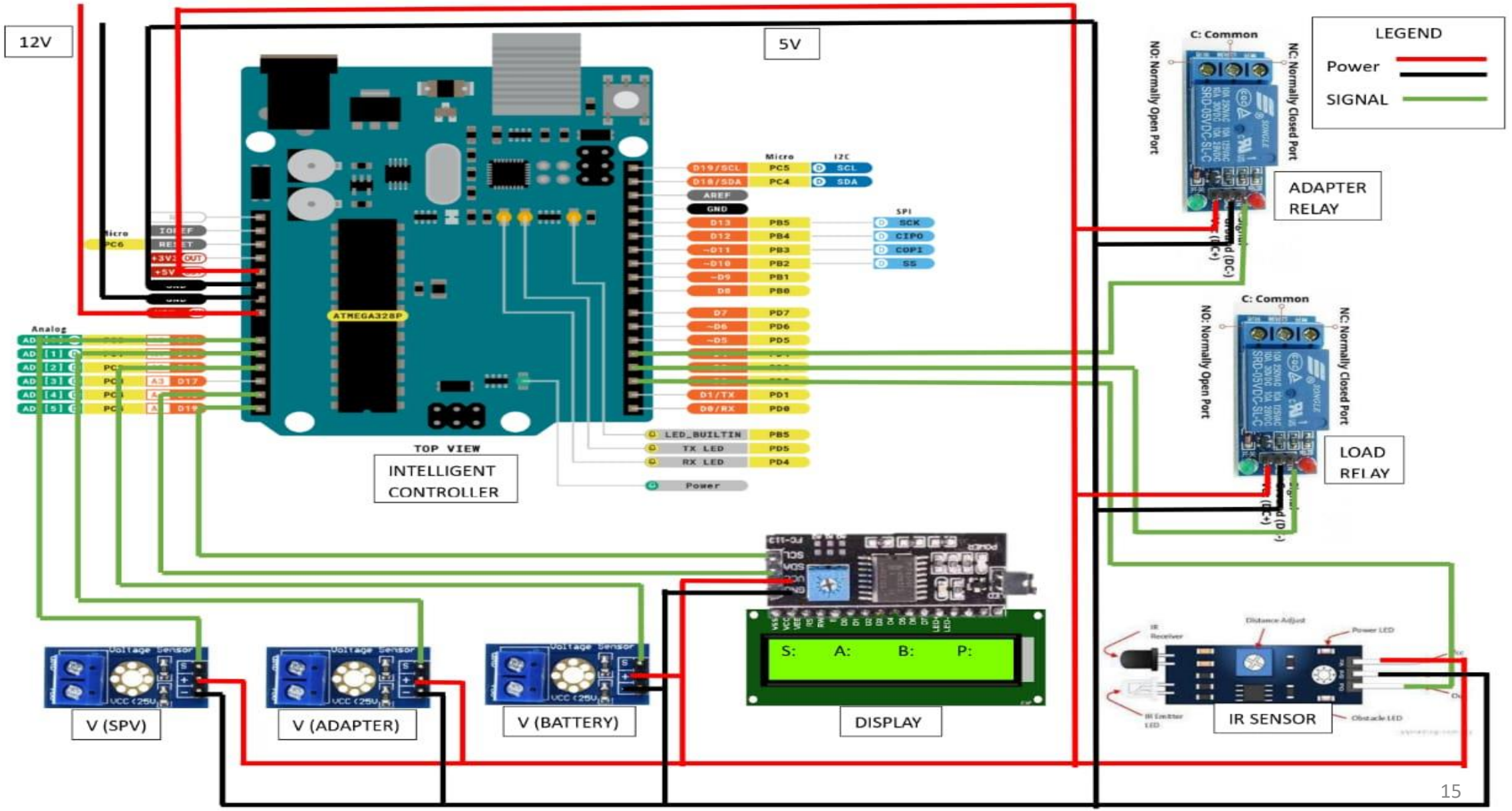
The Optimal Techno-Economical Configuration in our case was found to be an SPV capacity of 20Wp and a Battery Capacity of 12Ah, considering grid availability of 60% at the site

ELECTRICAL DESIGN OF SYSTEM



CIRCUIT DIAGRAM OF THE ELECTRICAL COMPONENTS OF THE DEVELOPED SYSTEM

DESIGN OF THE NEWLY DEVELOPED INTELLIGENT CONTROLLER

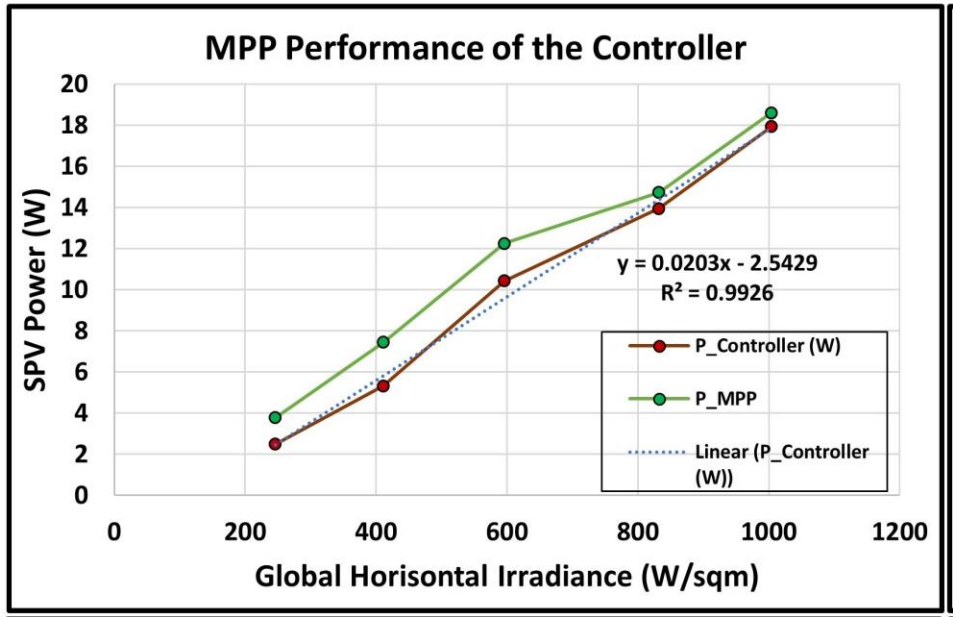


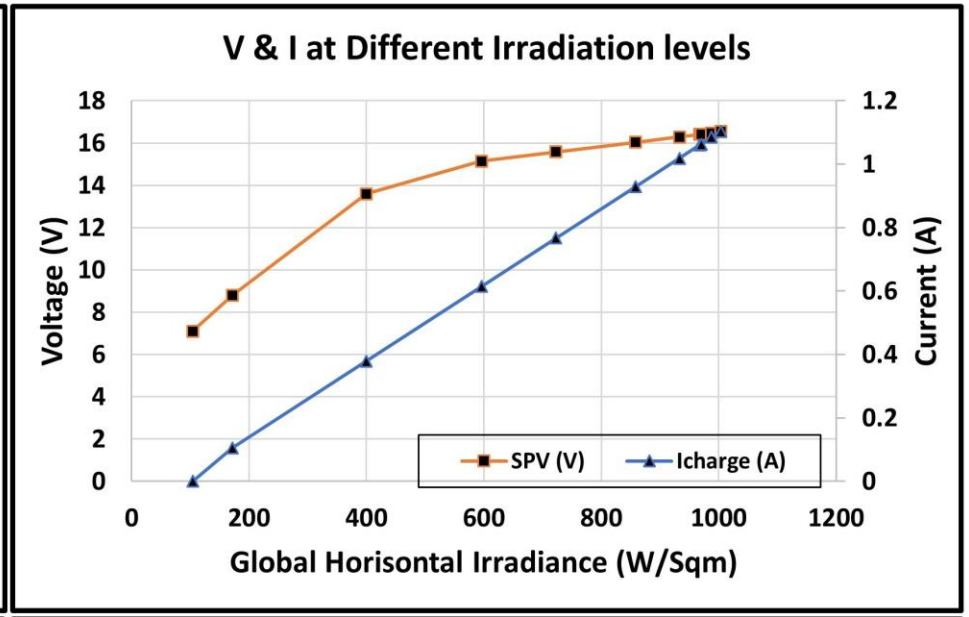
FEATURES OF THE CONTROLLER

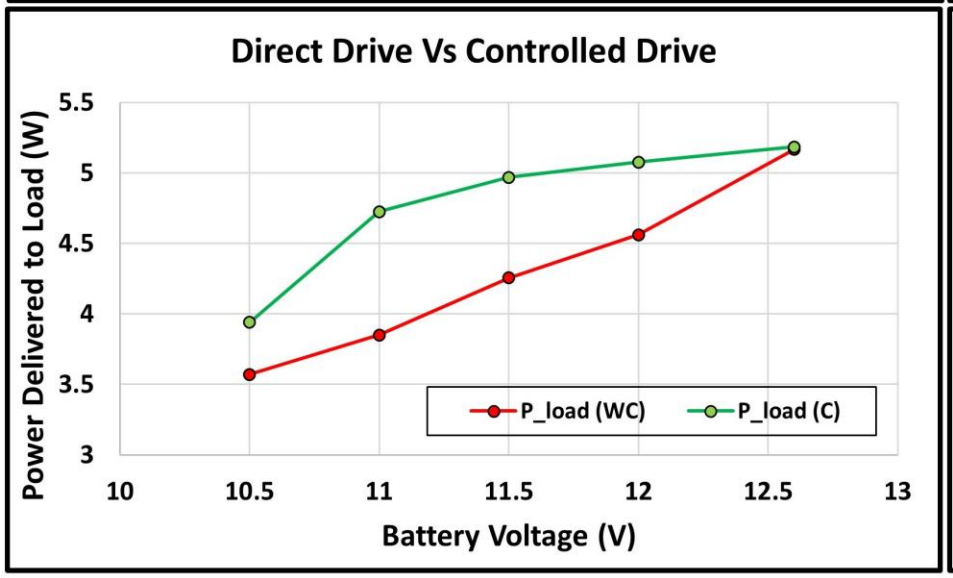
The following are the features of the newly developed controller:

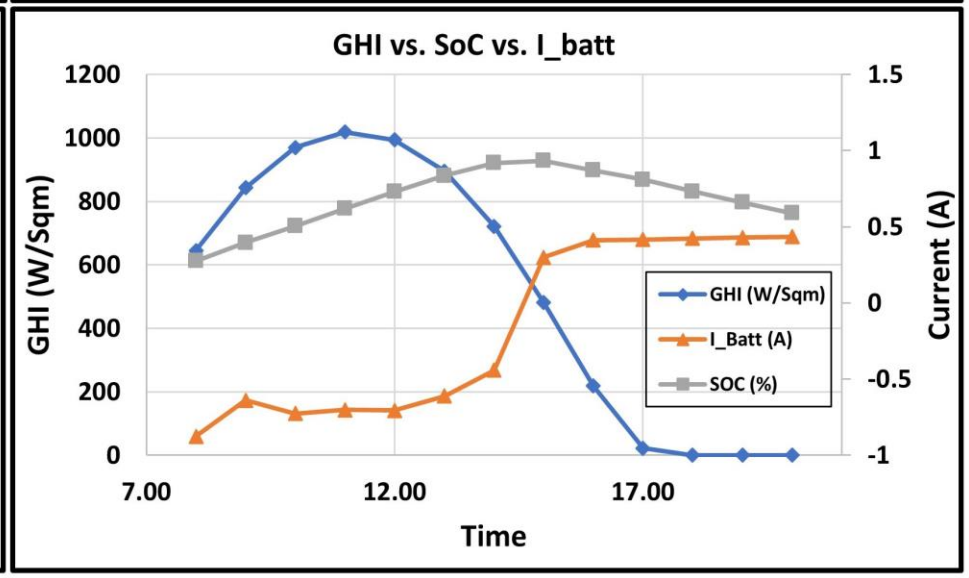
- It will operate the machine from DAWN TO DUSK, which will help to maintain the stored power in the battery for the next day. As the school hours are in the day time.
- MPPT function for optimal power extraction from the SPV.
- Battery overcharge and deep discharge protection.
- Revalidation of the dispensed pad using an IR Sensor.
- Automatically switching between battery power that is recharged using solar energy and grid power to ensure the machine is always ready for operation.

PERFORMANCE ANALYSIS



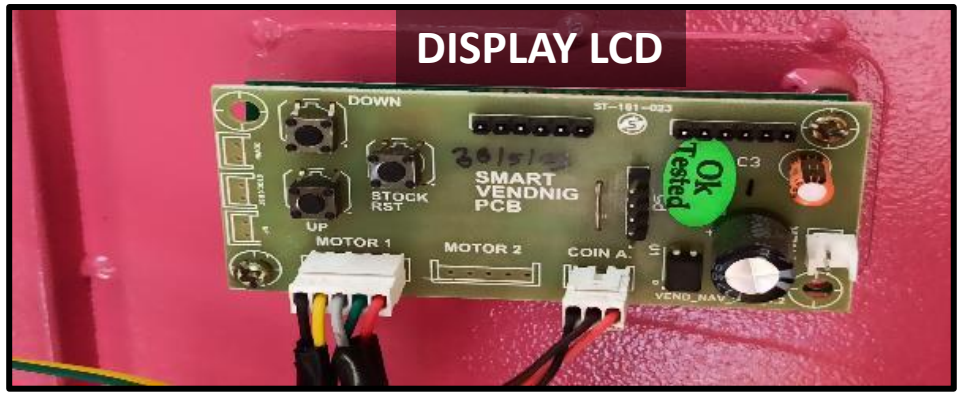


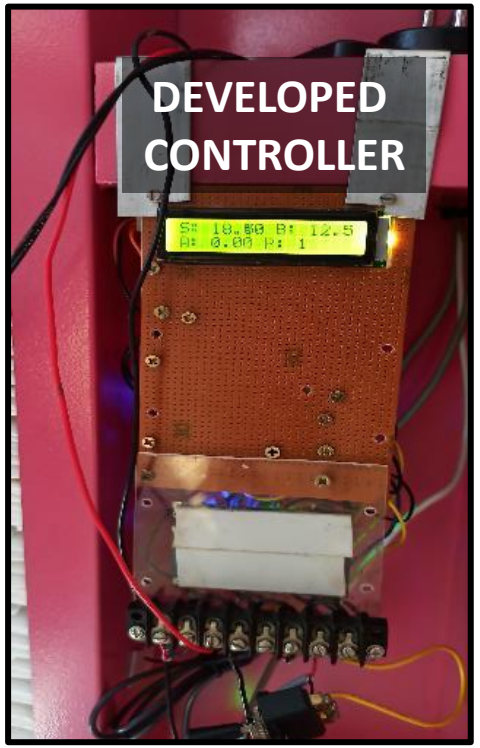


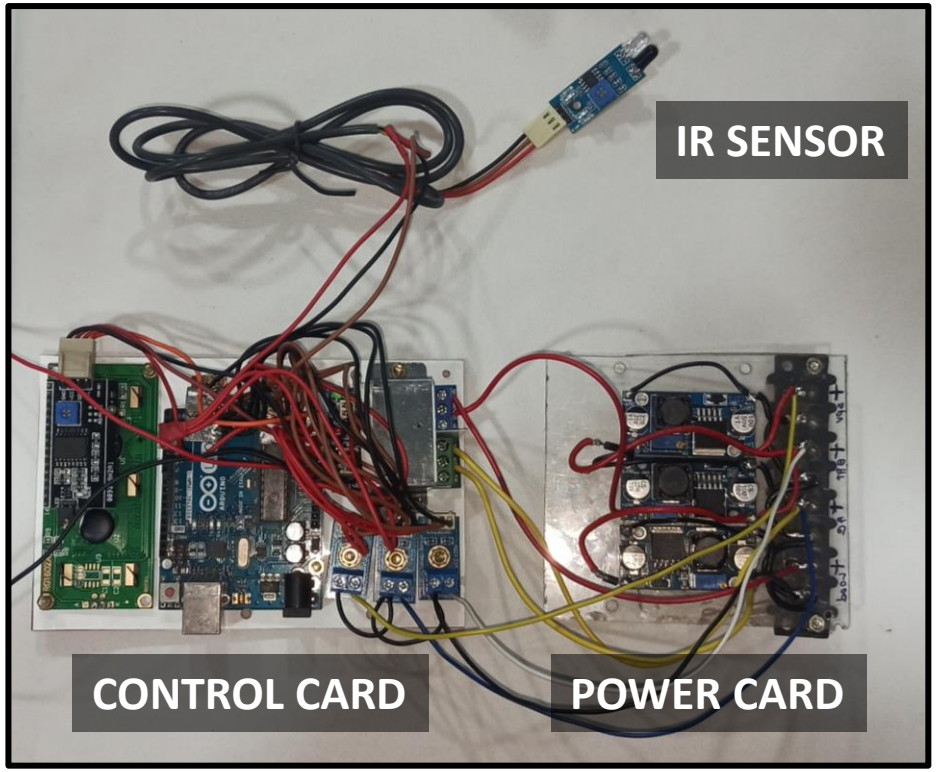


- The Controller closely mimics the MPPT line of the Solar Panel. Most of the Power could be extracted from the SPV.
- Direct drive delivers variable power to the load. Instead, a controlled drive delivers almost constant power.
- VI curve shows that at a GHI of 107W/sqm, no power is obtained from the SPV. Power is obtained thereon.
- Battery gets charged from the SPV till 15:00, after which the battery discharges. Min SOC is 27% and maximum is 98%. Battery discharges in 7 hrs.

SNAPSHOTS AND OPERATIONAL VIDEO







SOLAR OPERATION

GRID OPERATION

WORK PLAN

WORK PLAN OF THE PROJECT																		
WORK PACKAGE	**DELIVERABLES**	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**XIII**	**XIV**	**XV**	**XVI**	**XVII**	**XVIII**
A	**Baseline survey of the project site**																		
B	**Design and simulation of the system**																		
C	**Material Procurement**																		
D	**Fabrication of the unit**																		
E	**In house testing of the fabricated unit**																		
F	**Installation and Performance evaluation at site**																		
G	**Training, Comissioning and handover of the unit**																		
H	**Technical Handholding and report preparation**																		
I	**Development of Business plan & Commercialization of the final product**																		

BUDGET

ITEMS	COST (Rs.)	COST (EUR)	Expenditure (INR)
A. NON RECURRING			
Fabrication of the Solar Sanitation napkin Dispenser system	1,20,000	1560	80,000
Development and integration of mobile charging station	30,000	390	5,000
Development and integration of low power IoT module	35,000	455	8,200
Development and integration of intelligent load controller	30,000	390	17,500
A. TOTAL NON-RECURRING	2,15,000	2795	11,0700
B. RECURRING			
Manpower Cost	50,000	650	25,000
Travel	28,000	364	15,000
Contingency	7,000	91	4,000
Consumables	46,000	598	32,000
B. TOTAL RECURRING	1,31,000	1703	76,000
C. TOTAL EXPENDITURE (A+B)	**3,46,000**	**4498**	**1,86,700**

WORK TO BE DONE IN NEXT 6 MONTHS

- Rigorous testing of the controller.
- Final Fabrication and Installation of the controller.
- Development of an efficient dispensing system.
- Design of community-level system.
- Development and testing of the IoT module.

THANK YOU

Ensuring sustainable sanitary hygiene for rural school girls